

□ Allestimento sperimentale

□ Gen. Corr. (A.O. + BST) ($T \approx 0.1 \div 10 \mu s$)

□ Trans - Z

□ Oscillatore x onda Triangolare

□ Verifica legge F_{MI} vs. L (sequ. → Anal FFT)

□ Campo di misura : 0 - 3 m / Risoluz : $\approx 1 \text{ mm}$

□ PLL

□ $C > 1$? Aggancio a f_{MI} o ad armoniche ?

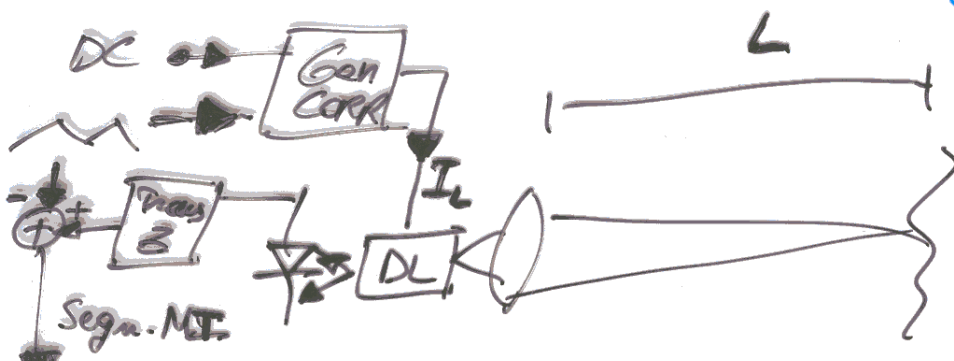
□ Limitaz. su L ?? ($f_{min} - f_{max}$)

□ Soppressione Fluttuazioni Voc e perosità aggancio (salto di fase)

□ (? Realizzaz. con contatore ? ⇒ conteggio N Frange)

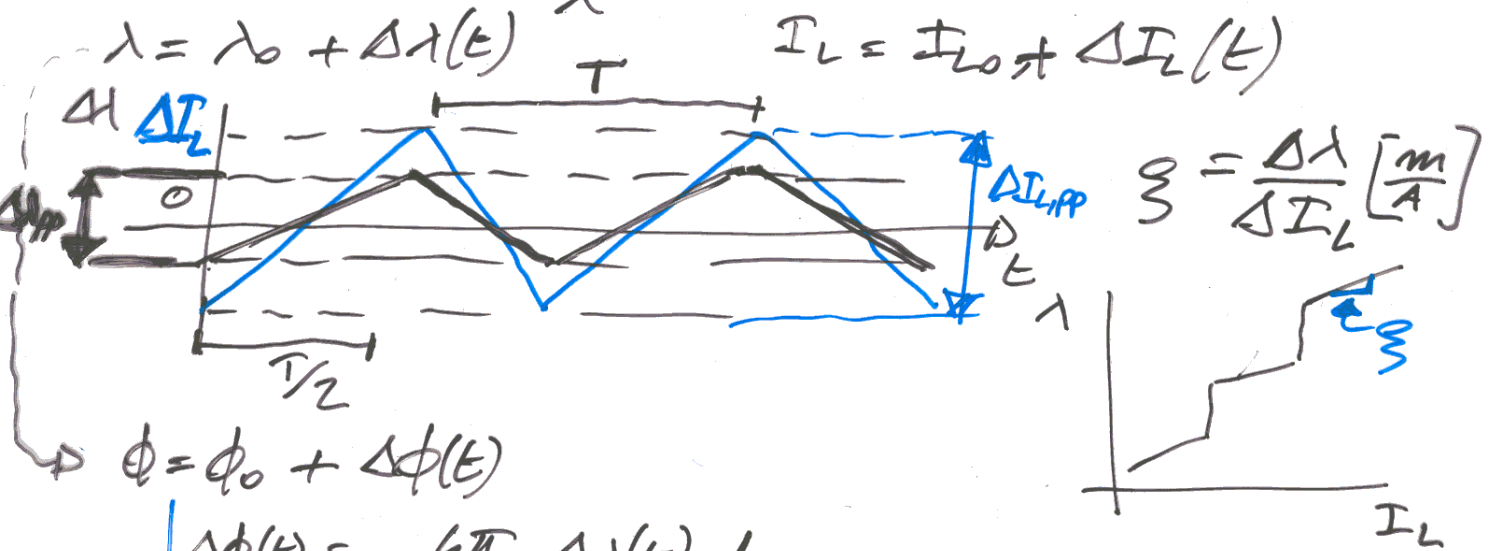
Telemetro a M.I. Analogico

①

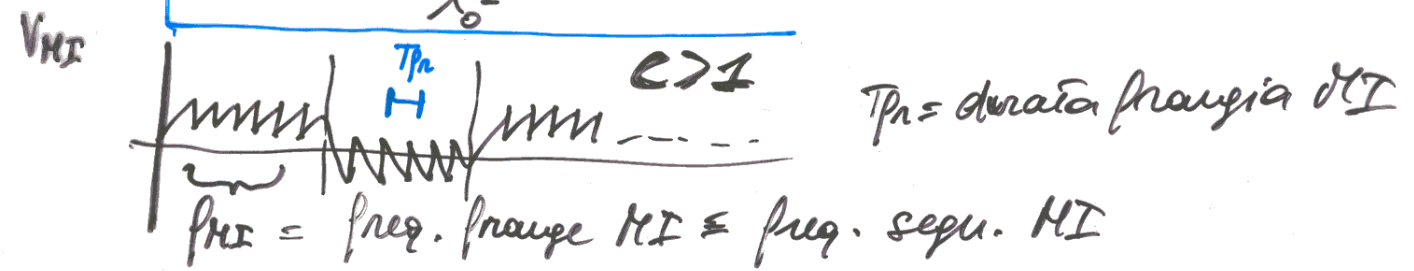


Elaboraz Segnale \rightarrow $V_{out} \propto L$ $V_{out} = K \cdot L$

- Principio : interferometro a M.I. + modulaz. λ
- NO Elaboraz. digitale
- $\phi = 2 \cdot K \cdot L \approx \frac{4\pi}{\lambda} \cdot L$



$\phi = \phi_0 + \Delta\phi(t)$
 $\Delta\phi(t) = -\frac{4\pi}{\lambda_0^2} \cdot \Delta\lambda(t) \cdot L$



$f_{M.I.} = \frac{1}{T_p}$

$f_{M.I.} = \text{freq. frangia M.I.} \approx \text{freq. sequ. M.I.}$

Ricavo T_{pr}

$$\Delta\phi_{tot} = -\frac{4\pi}{\lambda_0^2} \cdot \Delta I_{p-p} \cdot L = -\frac{4\pi}{\lambda_0^2} \cdot g \Delta I_{L,pp} \cdot L$$

Lo avviene nel tempo $\frac{T}{2} \Rightarrow 2\pi : |\Delta\phi_{tot}| = T_{pr} : \frac{T}{2}$

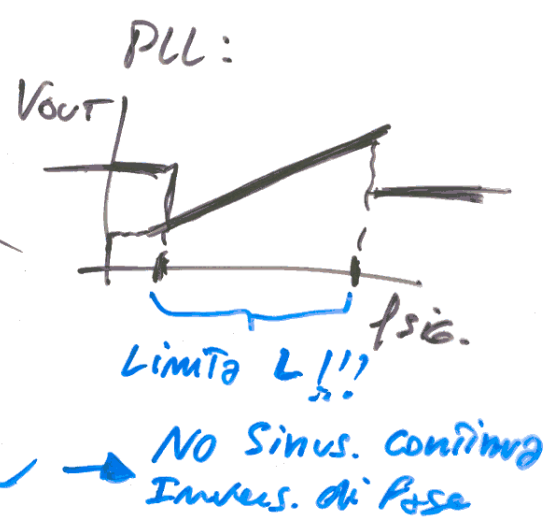
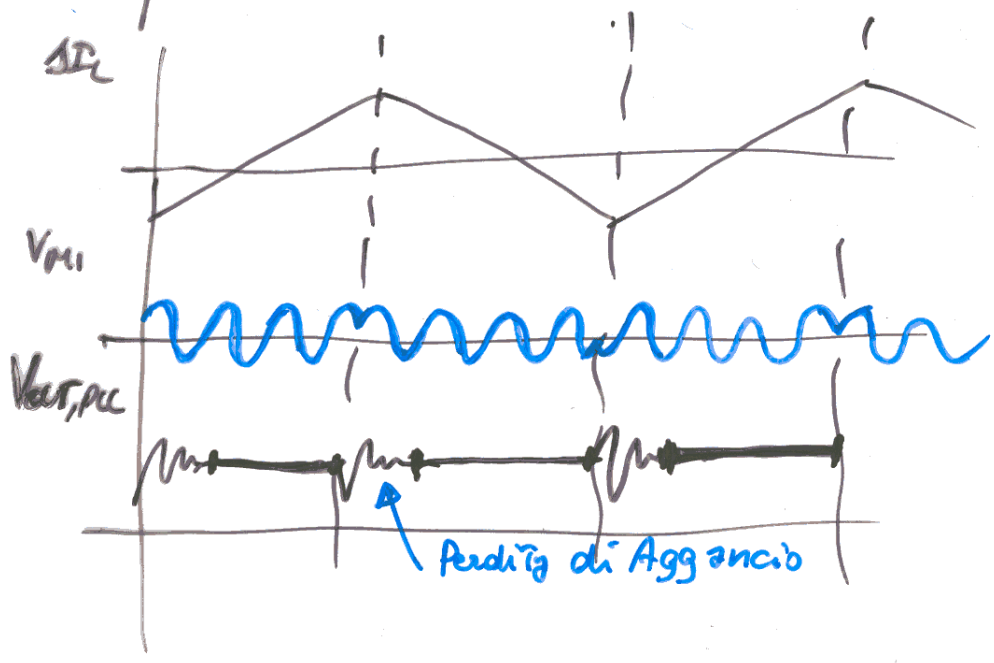
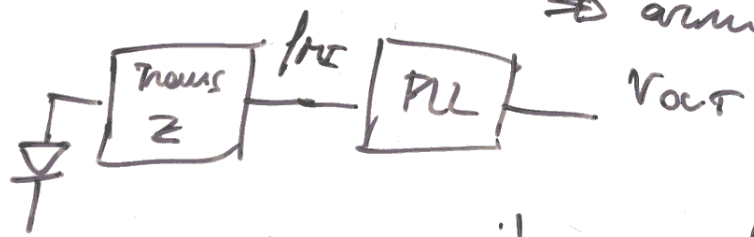
$$T_{pr} = \frac{T}{2} \cdot \frac{2\pi}{|\Delta\phi_{tot}|} = + \frac{T \cdot 2\pi \cdot \lambda_0^2}{2 \cdot \frac{4\pi}{2} \cdot g \Delta I_{L,pp} \cdot L}$$

$$f_{MI} = \frac{1}{T_{pr}} = \frac{4 \cdot g \cdot \Delta I_{L,pp} \cdot L}{T \cdot \lambda_0^2}$$

□ Schema Blocchi Elaboraz. Segnale

□ PLL (da seg. MI → estrae $f_{MI} \propto L$)

□ ? Problema? Segn. MI a dente di sega ⇒ armoniche di f_{MI}



$L_{MAX} < \frac{L_{COHER.}}{2}$ or $L_{MAX} < \frac{L_{COHER.}}{2}$ (3)

MOTIVO: Rumore di Fase

$L_{COHER.} \approx c \cdot T_{COHER.} = c \cdot \frac{1}{\pi \delta \nu} =$

$\delta \nu \approx 3 \div 30 \text{ MHz}$

$L_{COHER.} \approx 3 \div 30 \text{ m}$

$L_{MAX} \approx 1 \div 10 \text{ m}$

$\therefore -\phi = 2 \cdot k \cdot L = \frac{4\pi}{\lambda} \cdot L$

↑ larghezza di Rigo

$\lambda = \lambda_0 + \delta \lambda \Leftrightarrow N = N_0 + \delta N$

$\frac{\delta \lambda}{\lambda_0} = \frac{\delta \nu}{\nu_0}$

$\delta \lambda = \frac{\lambda_0}{\nu_0} \cdot \delta \nu = \frac{\lambda_0^2}{c} \cdot \delta \nu$

interf. + base $(\lambda) \Rightarrow \phi$

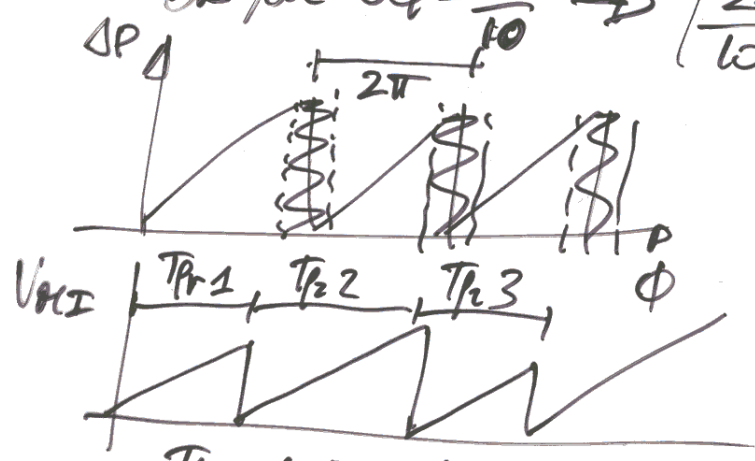
fluttuaz. $\lambda \Rightarrow$ fluttuaz. ϕ

$\delta \nu \rightarrow \delta \lambda \rightarrow \delta \phi$ ← Rumore di fase

$\delta \phi = -\frac{4\pi}{\lambda_0^2} \cdot \delta \lambda \cdot L = -\frac{4\pi}{c} \cdot \delta \nu \cdot L$

se $\delta \phi = 2\pi \Rightarrow$ NO segu. interf.

OK se $\delta \phi = \frac{2\pi}{10} \Rightarrow \left| \frac{2\pi}{10} \right| = \frac{4\pi}{c} \cdot \delta \nu \cdot L$



$L_{MAX} = \frac{c}{20 \delta \nu}$

$TPr1 \neq TPr2 \neq TPr3$

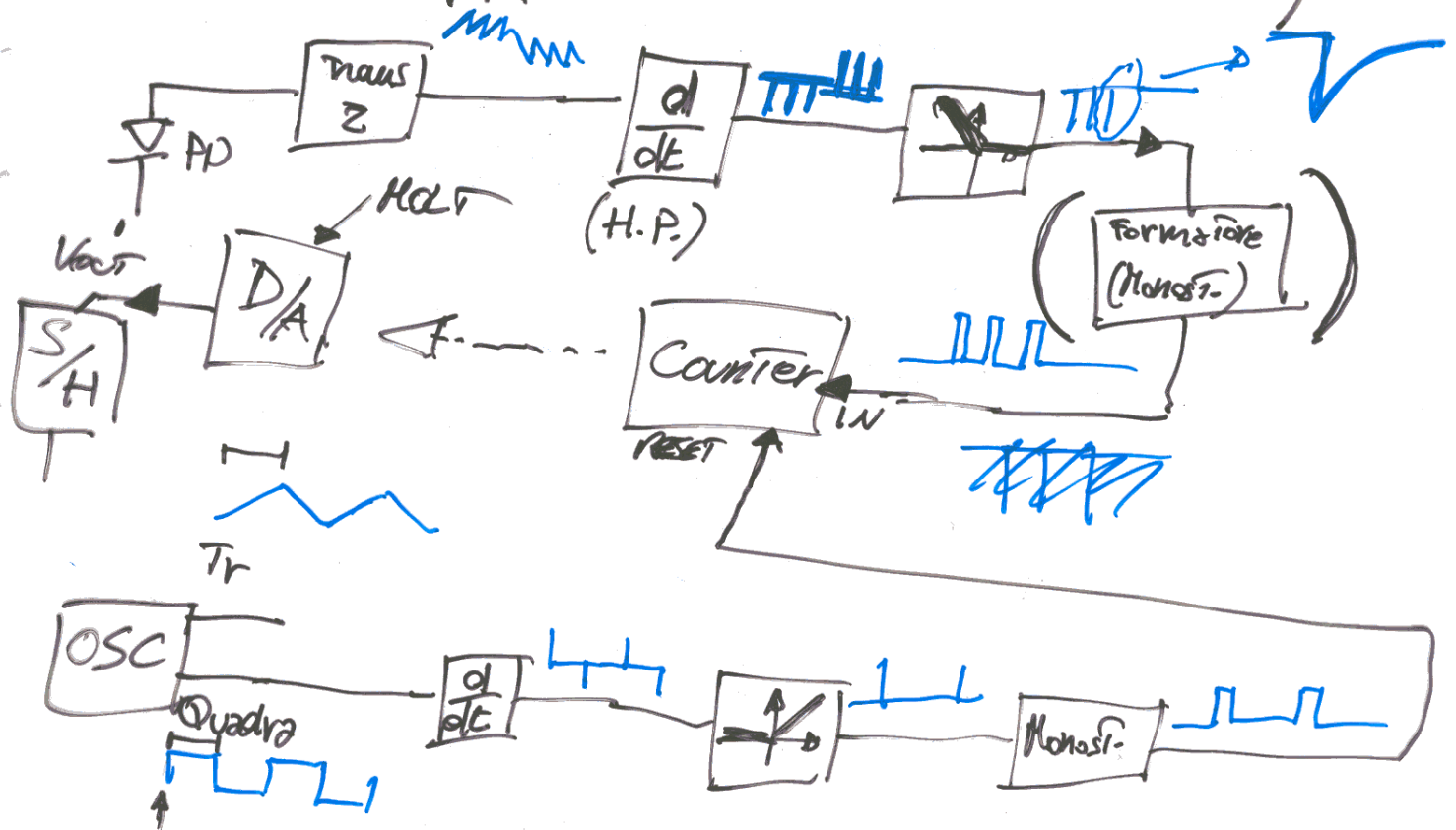
□ ? L_{max}? Insufficiente livello pot. retroiniettata nel laser - □ Diffusione (bersaglio) □ Speckle (ottica)

↳ Simile a Telemetro Sinus.

□ Metodo del conteggio del n° di Frange

$N = n^{\circ} \text{frange in } T/2$

$$N = \text{int} \left(\frac{\Delta\phi_{\text{TOT}}}{2\pi} \right) = \text{int} \left(\frac{2 \cdot \beta \cdot \Delta I_{LAP}}{\lambda_0^2} \cdot L \right)$$



$$L = N \cdot \frac{\lambda_0^2}{2 \cdot \beta \cdot \Delta I_{LAP}}$$

discretizzazione → $\Delta L_q = \frac{\lambda_0^2}{2 \cdot \beta \cdot \Delta I_{LAP}}$
 quantizzazione. Risoluzione

Esempio: $\lambda_0 = 0.8 \mu m$
 $\xi = 5 \div 10 \text{ pm/ma}$ (5 tip.)
 $\Delta I_{pp} = 2 \text{ mA}$

$$\Delta L_q = \frac{0.64 \cdot 10^{-12}}{2 \cdot 5 \cdot 10^{-12} \cdot 2} = \cancel{0.32} \cdot 0.032 \text{ m} = 32 \text{ mm}$$

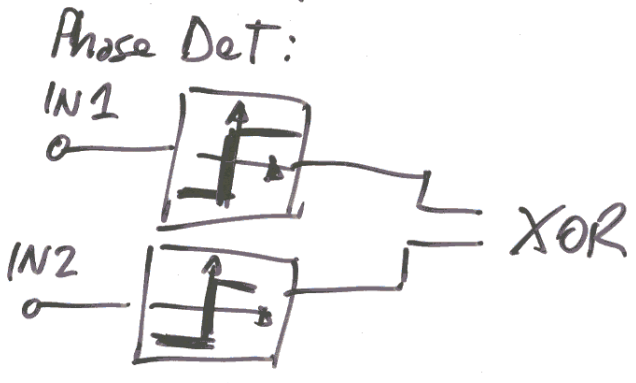
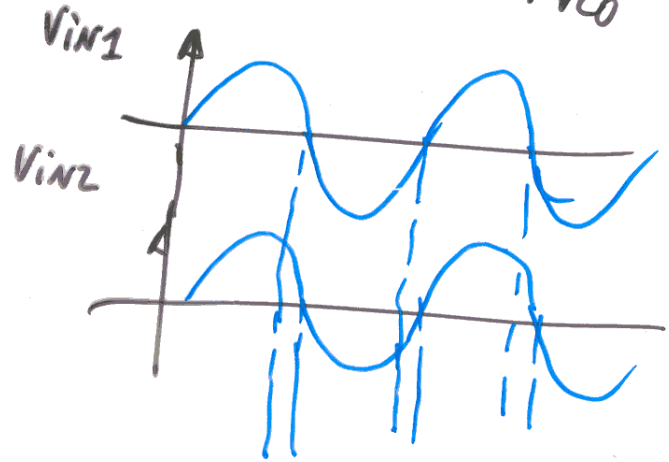
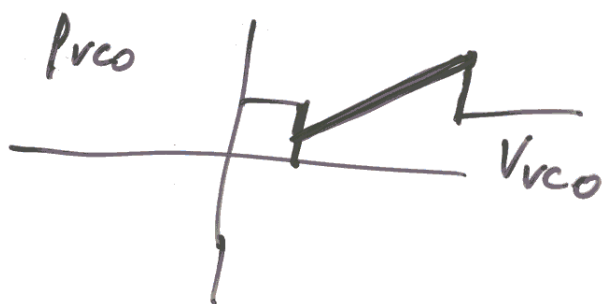
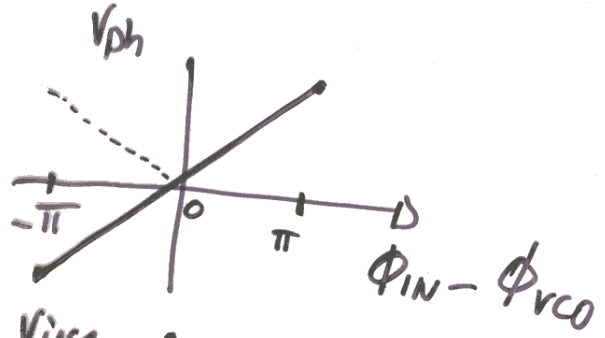
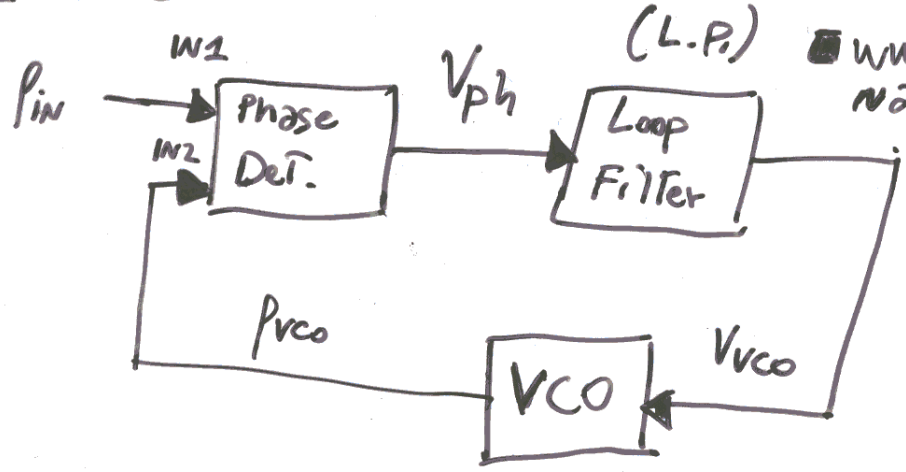
Oss.: x il metodo a conteggio di Frangé,
 la δN NON influisce sull'accuratezza
 (se $L < L_{max}$)

■ J.B. ENCINAS "Phase Locked Loops", Chapman & Hall

Coll: EL4 3

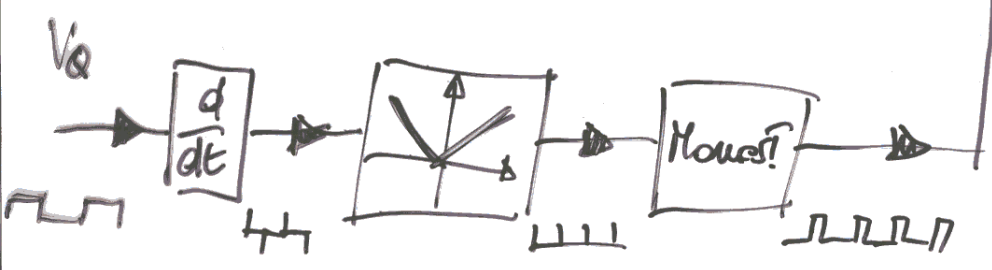
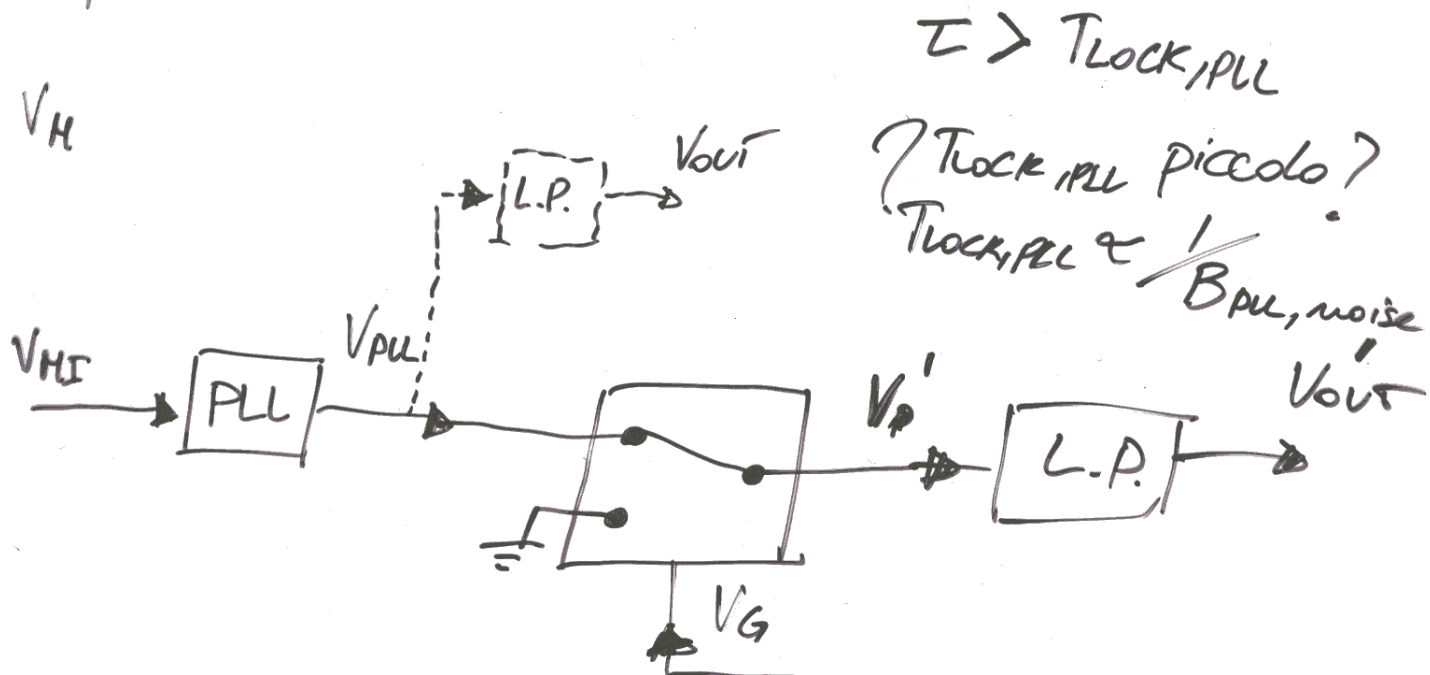
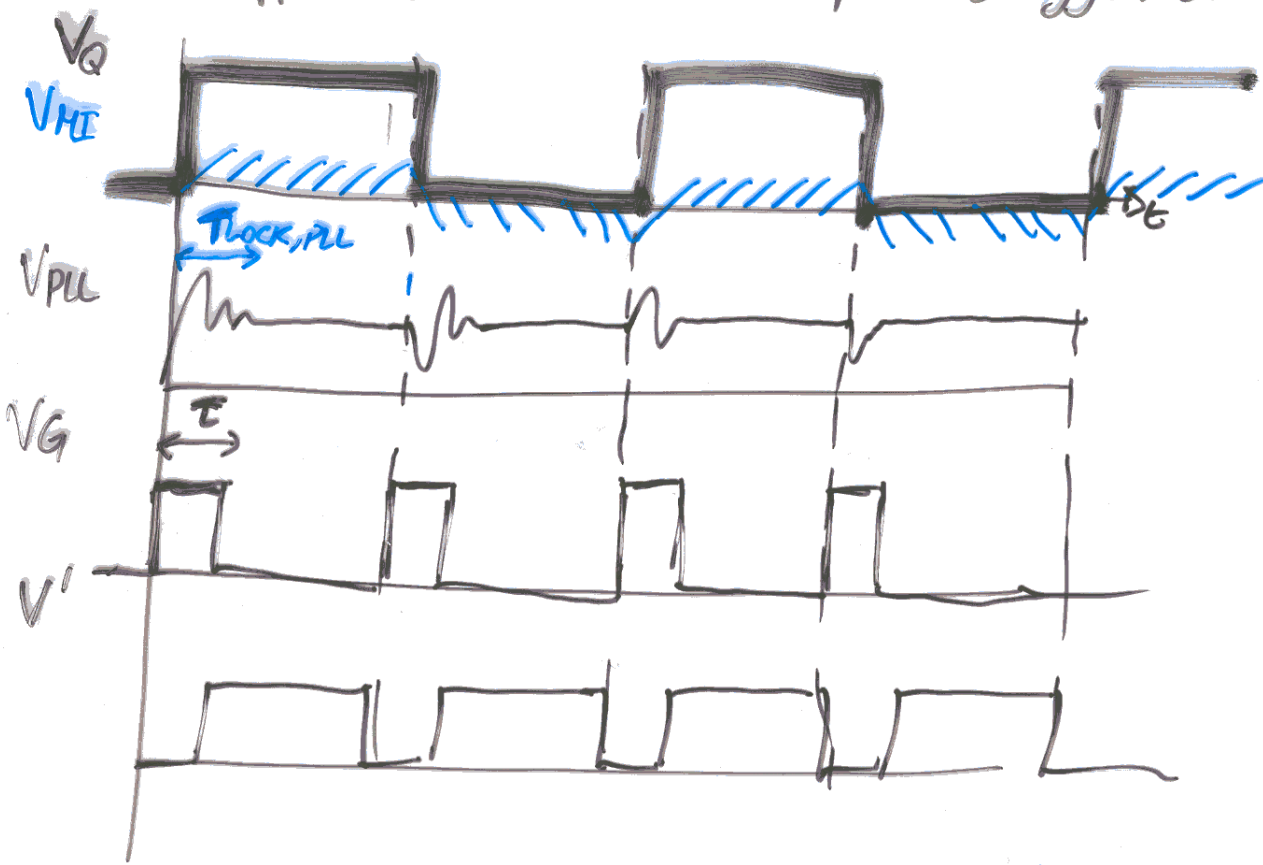
■ www.voguelph.co/mantion/gadgets/pll/pll.htm

□ PLL



Soppressione fluttuazioni x perdite aggiuntive

6




SCELTA LASER / PD

□ T. S.

- λ visibile
- $\delta\nu$ non imp. / car. spettrali non imp.
- HITACHI / OPNEXT HL6315G € 15-20
- $\lambda = 635 \text{ nm}$ $P_0 = 3 \text{ mW}$
 $I_{op} = 30 \text{ mA}$ $I_{th} = 25 \text{ mA}$

- ~~□ / CG ?~~
- Fotodiodo:
 - $\phi @ \lambda_{op}$, area piccola
 - $C_j \leq 10 \text{ pF}$
 - Banda $\approx 10 \text{ MHz}$

□ T. MI

- Singolo modo longitudinale } 
- $\delta\nu$ piccola (2-5 MHz)
- Buon compov. in regime MI
- HITACHI / OPNEXT HL8325G € 100
- $\lambda = 820-840 \text{ nm}$ $P_0 = 40 \text{ mW}$
 $I_{op} = 70 \text{ mA}$ $I_{th} = 40 \text{ mA}$
 $I_{ph} = 100-400 \mu\text{A}$ ~~□ / CG~~

□ Fotodiodo: PD di monitor

↳ Banda $\approx 100 \text{ kHz} - 1 \text{ MHz}$